



# Renewable Energy for the 21<sup>st</sup> Century



# Global Energy Demand

- Will increase 54% by 2025.
- Demand for Electricity will almost double.
- Crude Oil Consumption will increase by 50% to 121 million barrels per day.
- Fossil fuels will account for 85% of the world's primary energy mix.



# U.S. Liquid Fuel Import Status

1970	30% of Liquid Fuel Imported
2004	58% of Liquid Fuel Imported
2025	68% Importation is Projected



# California's Energy Future

- 60,000 KW of new electric supplies needed by 2030 (100 new power plants).
- On-road vehicles will reach 35.6 million by 2025, up from 25.6 million in 2003.
- On-road gasoline usage could reach 17-19 billion gallons by 2025, up from 15 billion in 2003.
- California will become more dependent on imported petroleum and LNG.



# U.S. Fuel & Ethanol Demand

- 125 Billion Gallons of Gasoline consumed in 2004.
- 3.4 Billion Gallons of Ethanol were produced from Corn Kernels.
  - California consumed almost 30%.
- The demand for Oxygenated Fuel is Growing Rapidly.
  - MTBE Ban
  - Proposed federal standard for eight billion gallons by 2012.
- Potential Demand - 25 Billion Gallons within 15 Years



# Benefits of Ethanol as a Liquid Fuel

- Volume extender when blended with gasoline
- Octane enhancer
- Reduces CO<sub>2</sub> emissions
- 10% blending would reduce America's emissions from automobiles by 21%
- Compatible with existing gasoline distribution systems
- Reduces Petroleum Imports



# California's Waste Resources

- The state generated an estimated 74 million tons of solid waste in 2004.
- After recycling and diversion, 32 million tons of organic waste were buried in landfills.
- California must dispose of 33 million used tires per year, one-third of which are placed in landfills.





# California Agriculture

- Generated approximately 22 million tons of waste in 2004.
- 9.5 million tons came from orchard and vineyard prunings, field and seed crop, and vegetable crop residues.
- 12.5 million tons came from animal wastes.



# The BRI Energy technology could enable California to...



- Produce as many as two billion gallons of fuel-grade ethanol annually from its post-recycled organic waste streams.
- Provide communities with long-term, low-cost renewable electricity (green power).
- Produce ethanol efficiently and cost effectively, even if federal ethanol subsidies were phased out.
- Become an exporter, rather than a 99% importer, of ethanol.
- Extend by up to 80% the useful lives of its existing landfills.



- Eliminate the need for the agricultural land spreading of sewage sludge.
- Provide a constructive alternative to the open-field burning of agricultural wastes.
- Create a new industry and jobs for California's work force.
- Bring to California millions of dollars of federal incentives that otherwise would have gone to the Midwest.

**and do all of this  
while contributing  
to an improved  
environment!**



# The BRI Technology

BRI Energy, Inc., has developed a process that profitably co-produces ethanol (and/or hydrogen) and electricity from such feedstocks as:

- Municipal Solid Waste
- Biosolids & Animal Wastes
- Green Waste
- Agricultural Residues
- Used Tires & Plastics
- Wood Wastes
- Forest Thinnings
- Coal & Other Hydrocarbons
- Refinery Tars & Waste Oils

A patented microorganism ingests synthesis gas (gasified wastes) and emits ethanol, hydrogen and water.



# The Technology

- Deconstructs (gasifies) the carbon molecules in organic feedstocks through an enclosed thermal process.
- Can create electricity without combustion. Waste heat (generated during the cooling of the syngas) is used to create the high temperature steam that powers electric turbines.
- Consumes 95% of any carbon-based feedstock, leaving a final residue of non-hazardous ash.
- Yields 85 gallons of ethanol per dry ton of biomass (up to twice that amount from used tires or auto fluff).

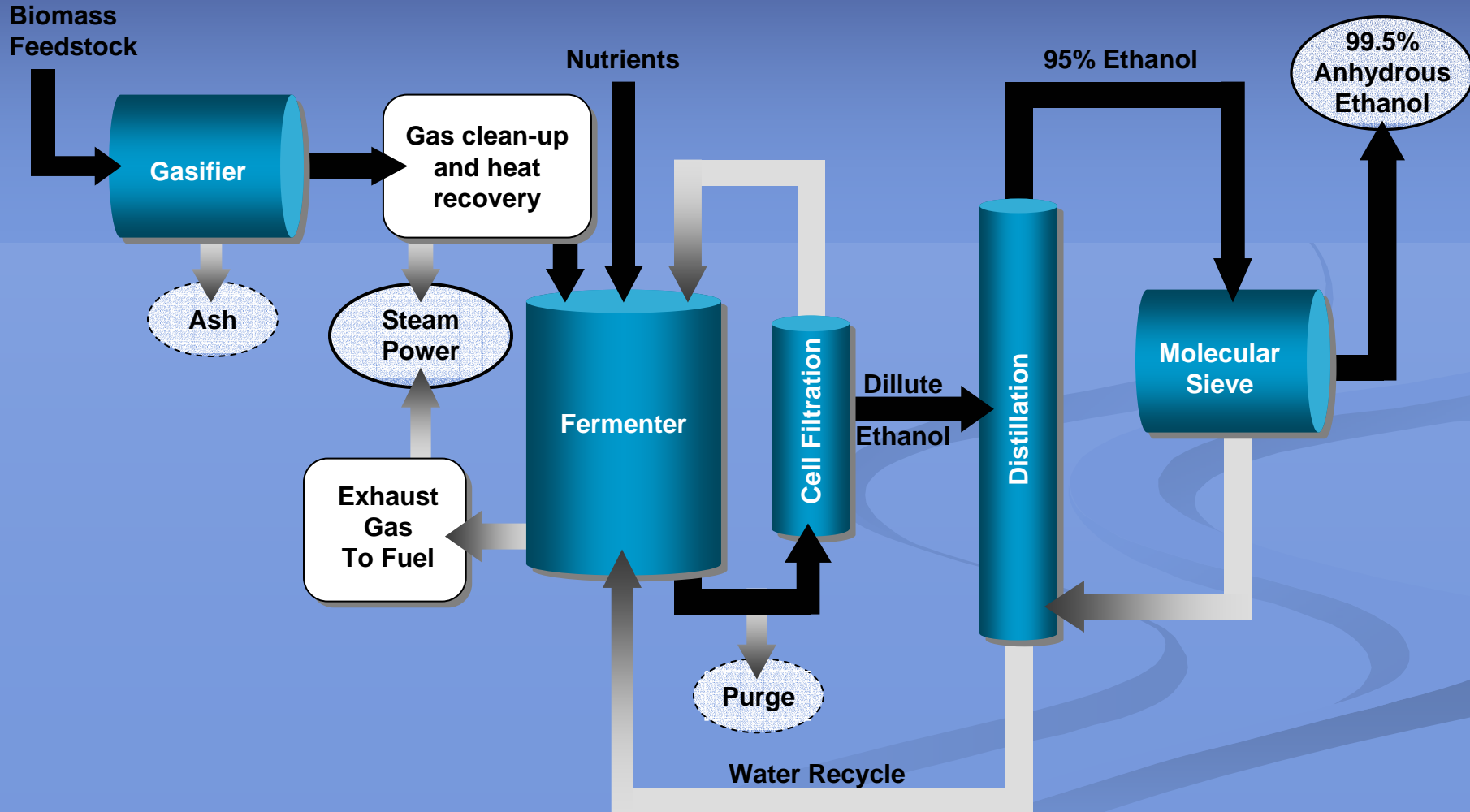


# What is unique about the Technology?

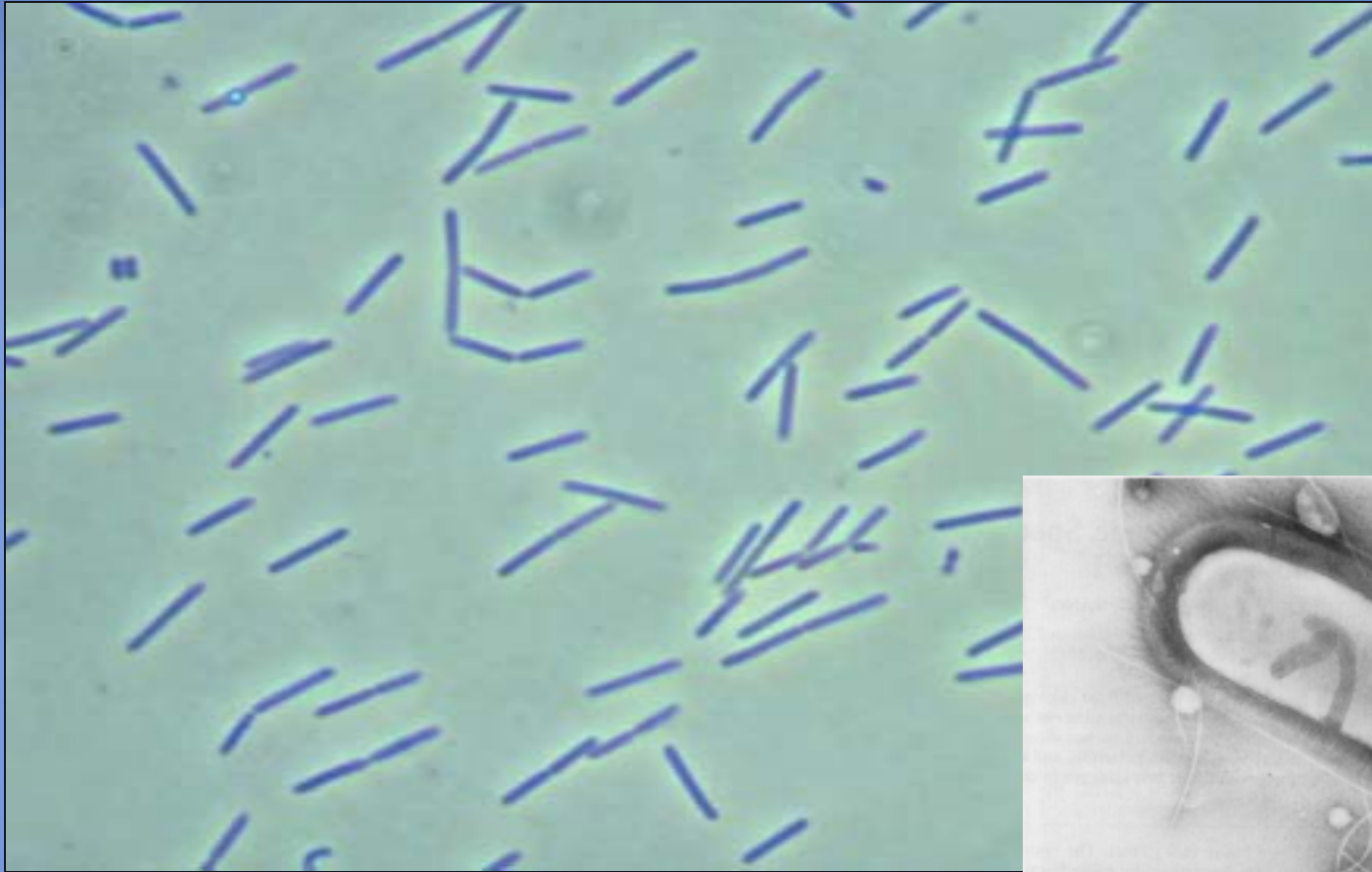
- The entire process takes seven minutes, whereas prior sugar fermentation technologies require 36-48 hours.
- Its feedstocks can be blended.
- Handles up to 40% moisture content.
- The process is odorless.
- Protein can be created from the reactor purge.
- Its bacteria culture is anaerobic. It produces no undesirable by-products, creates no health or environmental hazards.



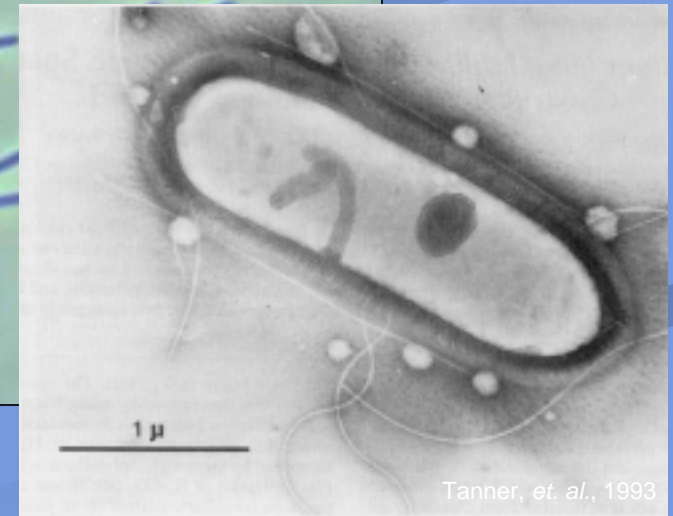
# BRI Process Schematic




# Patented Bacteria used for the Production of Ethanol



**Clostridium ljungdahlii**







## **BRI Plants are modular, and therefore, scalable. One configuration will:**

- Combine
  - Two Gasifiers (each with capacity of 125-150 tons of waste per day)
  - Two Biocatalytic Reactors
  - Final Filtration Step
- Process up to 100,000 tons of green waste annually.
- Produce 8.6 million gallons of ethanol.
- Generate 6.4 MW of power (4.25 MW of marketable energy, in excess of what is required to run the plant).
- Require three-four acres.



# BRI Energy Plant

## *Another Potential Configuration*

- Would produce 48 million gallons of ethanol and generate 35.5 MW of power (23.5 MW being surplus to plant operations),
- Consume 750,000 tons of municipal solid waste annually, and
- Require Seven Modules.

# Pilot Plant Facility



# Gasifier





# Biocatalytic Reactor



# Distillation







# Is the BRI Process clean?

**YES...**

The process is environmentally superior to any other technology currently being utilized to dispose of organic wastes, create fuel or produce electric power.





# Emissions

## Gasification

There are no air emissions from the gasification step. The syngas is treated through “scrubbing” and activated carbon filtration and then fed directly to the bacteria culture.

## Electricity Generation

Waste heat from the cooling of the synthesis gases is used to create high temperature steam. There is no combustion associated with this step of the electricity generation process.

The residual syngas could be combusted to produce additional high temperature steam, but as these gases will be scrubbed and will pass through activated carbon filtration, they will burn 70% cleaner than natural gas.



# Waste Streams

## Inorganic Material

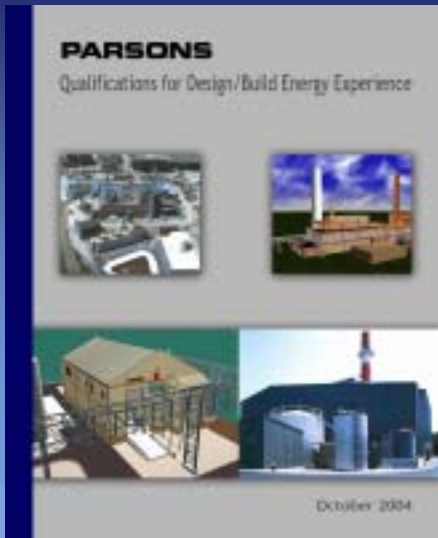
Inerts such as metals or glass will be ejected for landfilling or recycling after the first stage of thermal gasification. By weight, these will comprise approximately 17.5% of the materials found in municipal solid waste.

## Ash

5% of the organic material will remain as a non-hazardous ash.

## Wastewater

The syngas is “scrubbed” prior to entering the fermentation vessel. BRI will pre-treat the waste stream before it is recycled or sent to a public wastewater treatment plant.



# Technology Partners

- Parsons Corporation will be responsible for the design, construction and operation of BRI's plants.
- Katzen International will provide biocatalytic process design, efficiency, optimization and technical support.
- Bioengineering Resources, LLC will provide the support for its proprietary bacterial culture and biocatalytic systems.





## Technology Status:

- Parsons and Katzen have signed off on the feasibility study for the basic BRI module.
- Construction on BRI's first commercial plants expected to begin in 2005.
- Feedstocks for these plants will include green wastes, MSW, auto fluff and methane.





## In Summary, BRI will:

- Provide waste haulers, MRF and landfill operators with expanded revenue opportunities from their waste streams.
- Enable landfill operators to increase the amount of materials they can process under their existing permits.
- Reclaim up to 80% of the state's post-recycled organic wastes.
- Provide California with long-term, low-cost green power and liquid energy.
- Reduce greenhouse gases and provide a cleaner environment.



# The BRI Process will:

- Assist in developing cost-saving, environmentally-responsive methods for disposing of wastes.
- Respond to government mandates for the introduction of renewable fuels and clean electric energy production.
- Qualify California to receive millions of dollars of federal incentives that otherwise would have gone to the Midwestern corn-producing states.
- Convert vast quantities of the nation's waste into renewable fuel and electric power.



## The Process could:

- Turn California into a net exporter, rather than a 99% importer, of ethanol.
- Create a new renewable energy industry, with related employment and economic activity.
- Provide the ethanol and hydrogen to power the Governor's hydrogen highway.





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